Composite Sheets make Ultra-lite airbag housings possible

Vasant Pednekar
Application Development
LANXESS Corp.
Facts and Figures

- Employees worldwide: approx. 17,300
- 52 production sites worldwide
- Sales in the year 2012: EUR 9.094 bn
- Sales in the year 2013: EUR 8.300 bn

LANXESS is one of Germany’s most important providers of polymers and chemicals
High Performance Materials – High-tech plastics and High-end engineering know-how at its best

Smart solutions energized by LANXESS – innovative, flexible, fast

Tailored high-tech plastics compounds

X Durethan®

X Pocan®

Expertise for all stages of advanced component development
4.3% annual increase is needed to meet the CAFE standards

Courtesy: Drivethenation.com

Courtesy: ICCT
Goal was ascertained to reduce the weight of current plastic housing by 35%
HyPAC: Ultra-Lite Passenger Airbag housing

Cover → Cushion → Housing → Inflator
Development partners had a goal achievement target of 20 months

Synergy ensures success
Material Selection was based on criteria to substitute plastic airbag housing that meets extreme deployment loads.

Superior strength and Ultra-Lite Composite Sheets selected.

**Tensile modulus**

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<th>Overmolding Plastic</th>
<th>Composite Sheet</th>
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**Tensile Strength**

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_all values: conditioned, RT, comparable glass fiber content_
TEPEX® composite sheets enable lightweight solutions in the automotive industry

Composite sheet
- Thermoplastic (PA) matrix materials reinforced with woven fabrics
- Glass, carbon or aramid fibers (also hybrid)
- Continuous fibers (fiber length = part length)

Advantages of hybrid composite parts
- Low weight (density e.g., 1.8 kg/dm³)
- High stiffness, strength and energy absorption
- Simple recycling
- No investment for additional tools
Integration of composite sheet into the hybrid composite part through “in-mold forming”

- Heating up above melting point
- Shaping during the closing of injection molding tool
- Subsequent injection molding of rib pattern
- Demolding
Development of HyPAC concept with composite sheet and overmold resin

Composite sheet
TEPEX® dynalite

InMold-Forming

Forming

Overmold

Finished container

Hybrid composite parts as next generation in lightweighting technology
Design steps to optimize the material placement on the airbag housing

Building Design Space: Overmold

Defining loads: Inner Pressure

Topology Optimization Results

Displacement results from Simulation
Results to Actual component assisted precisely by topology optimization

Draft of the rib pattern → design in CAD

Resulting structure
Wall Thickness optimization of the composite sheet shows high reinforcement sections

- Blue: low stress areas
- Red: high stress areas* (higher reinforcement necessary)
Development of a passenger airbag housing based on composite sheet technology

Material Selection

- Injection molding:
  - Durethan®
  - BKV240H2.0XCP
  - Matrix: PA6
  - Reinforcement: 40% GF

- Composite Sheet:
  - TEPEX® Dynalite
  - 102-RG600(1)/47%
  - Matrix: PA6
  - Reinforcement/Fabric: Glass fibers (47% vol.)
  - Sheets: 1
  - 50/50 weave
CAE Simulation of fiber reinforced composite parts

Composite Sheet Forming

- Forming
- Fiber Orientation
- Mechanical Properties

Material model: Composite

Injection Molding of Overmold

- Molding
- Fiber Orientation
- Mechanical Properties

Material model: Overmold

Stress [MPa]  Strain [%]
Stress [MPa]  Strain [%]

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V. Pednekar, ACCE, September 2014
HyPAC Part: Dynamic calculations using CAE Simulation

Challenges

- Anisotropy
- Non-linearity
- Strain rate dependency
- Failure / Breakage
- Rotation of fiber directions / Non-orthogonal fiber directions
- Temperature dependency
- …

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Series-production status (All Plastic housing)

Optimized

> 35% weight reduction achieved
HyPAC Part: Dynamic calculations using CAE Simulation

- at 75% of Maximum Load
- All variants withstand the loads

Series-production status (All Plastic housing)

> 35% weight reduction achieved
Composite Sheets make Ultra-lite airbag housings possible

V. Pednekar, ACCE, September 2014

HyPAC Part: Dynamic calculations using CAE Simulation

- At Maximum Load
- First failures in the preliminary part
- Optimized design successful

Series-production status (All Plastic housing)

CAE Simulation: Pressure Loading

→ further optimization of the overmolding

Preliminary

Optimized

> 35% weight reduction achieved
HyPAC: Hybrid Passenger Airbag Housing Overview

Boundary conditions

Topology optimization and interpretation

CAE Simulation for Dynamic Analysis

Optimization
Joint development of a passenger airbag container based on composite sheet technology

- Partnership with Takata AG, Aschaffenburg – a leading producer of occupant-safety-systems
- Successful development of new passenger airbag housings with composite sheets
- First thermoplastic composite airbag housing to be used for passenger cars
- 35 % weight reduction compared to series part

Series production airbag container

- Weight: 550 g

Prototype container with composite sheets

- Weight: 360 g
Thank You for Your Attention

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